

LITTLE KNOWN FACTS ABOUT ALFALFA

Don Ball

Extension Agronomist

Auburn University

During the previous nineteen Kentucky Alfalfa Conferences, many topics pertaining to alfalfa have undoubtedly been addressed. In fact, some topics such as establishment techniques, varieties, and factors affecting yield are important enough that they have probably been discussed in one form or another during most of these conferences.

However, a twentieth-year state commodity conference is a milestone that deserves some special consideration, and which should justify inclusion of one or more unique topics on the program. This line of thinking led to idea that for this presentation it might be interesting to discuss some facts about alfalfa that are not frequently mentioned and that are therefore not known to many people, perhaps including to a number of participants in the 2000 Kentucky Alfalfa Conference.

As a consequence, this paper will be far less focused than most presented during this or earlier Kentucky Alfalfa Conferences. Instead, it will be a discussion of selected points pertaining to various aspects of alfalfa and alfalfa production. These points will vary in importance and practical application, but hopefully many or most will be of interest.

Nomenclature

The great taxonomist Linnaeus gave the scientific name *Medicago sativa* to the plant we call alfalfa, and this term is used for the species in scientific literature around the world. Though most alfalfa enthusiasts would be reluctant to agree that there is anything common about this wonderful forage crop, taxonomists refer to this species as "common alfalfa." There are more than 60 other species in the *Medicago* genus, about two-thirds of which are annuals.

Medicago falcata is a yellow-flowered perennial that is closely related to "our" alfalfa. In fact, it is believed that early hybridization of this relative of common alfalfa resulted in contribution of some valuable characteristics to the alfalfa with which we are familiar, with increased winterhardiness being especially important. The *falcata* species is so closely related that some taxonomists consider it to be a subspecies of *sativa* rather than a separate species.

In much of the world, including Australia, Europe, New Zealand, and South Africa, alfalfa is more commonly called "lucerne." Less widely known is the fact

that in other parts of the world alfalfa is (or has been) known by other common names including purple medic, snail clover, median herb, burgundy hay or burgundy clover, and Chilean clover.

History

Alfalfa originated in the vicinity of what is now Turkey and Iran, and undoubtedly was consumed by grazing animals long before there was any recorded history. It probably was also domesticated in this area, and some historians believe this may have occurred concurrently with domestication of the horse. It is thought to be the first plant grown strictly for forage.

The earliest clear reference to alfalfa was in Turkish writings dating from 1300 B.C. However, at least one historian believes it is probably that alfalfa was cultivated 8,000 to 9,000 years ago (6,000 to 7,000 B.C.). Regardless, it is clear that alfalfa was recognized as a valuable crop by early man.

It is known that maritime trade was well developed in the eastern Mediterranean as early as 4,000 B.C., thus alfalfa seed could have been a commercial commodity for many centuries before it was mentioned in historical documents. Once its value had been recognized, alfalfa was spread around the world from its original center of origin and cultivation. It is believed to have been taken to what is now Europe, to China, and to India soon after the birth of Christ, if not before. It is known to have been introduced by the Spanish to South America in the 16th century.

The first record of alfalfa being grown on the North American continent was in 1736 in Savannah, Georgia. However, this effort failed, as did most other early efforts to introduce alfalfa from Europe into the eastern portion of what is now the United States. This lack of early success was almost certainly due to acid soils.

Interestingly, alfalfa made its first important inroads into what is now the United States as a result of missionaries introducing it from Mexico and from Chile into California where soils were less acid than those near the eastern coast of North America. Subsequently, "Chilean clover" first became of importance during the Gold Rush period of 1847-1850.

European introduction eventually paid off as well, however. In 1857, a farmer from Germany who settled in Minnesota brought with him a plant he called "Ewiger Klee" (which means everlasting clover in German), but this was actually alfalfa. Though it initially performed poorly, he persisted in his efforts to grow it, and eventually had reasonably good success.

Many years later the Minnesota Experiment Station and the USDA used this germplasm in developing the variety 'Grimm', which probably contributed more to

the advancement of alfalfa in the United States than any other alfalfa introduction. Other winter-hardy germplasm sources brought in from Europe and Russia between 1850 and 1900 contributed as well.

Distribution And Uses

Alfalfa is truly an international crop, and it is grown in temperate climates throughout the world. It is grown from inside the arctic circle in the northern hemisphere to southern South America. It is grown from sea level in some countries to elevations greater than 8,200 feet. It is grown without irrigation in some areas where annual precipitation is only around 8 inches and in other regions in which there are more than 90 inches of precipitation. There is even some acreage in Kenya, a country which lies on the equator.

It is estimated that there are more than 70 million acres of alfalfa grown around the world, with significant acreages present in North America, South America, Europe, Africa, Asia, Australia, and New Zealand. The ten highest acreages among countries in the world as of 1985 are provided in Table 1.

Table 1. Leading alfalfa acreages in the world as of 1985.		
World Ranking	Country/Area	Acreage
1	United States	26,091,000
2	Argentina	18,533,000
3	Former USSR (Europe)	8,339,000
4	Canada	6,287,000
5	Italy	3,212,000
6	Former USSR (Siberia)	2,780,000
7	China	2,372,000
8	France	1,399,000
9	Rumania	988,000
10	Bulgaria	986,000
Source: Alfalfa and Alfalfa Improvement, ASA Monograph No. 29		

It is no secret that alfalfa can provide excellent nutrition for all types of forage-consuming animals. Production of more than 50 pounds of milk/dairy cow/day have been obtained from alfalfa/grass pasture alone. Beef gains of more than 1,000 pounds/acre have been reported on alfalfa/grass without supplementation. Fattening lambs have produced gains as high as 900 pounds/acre. (Incidentally, supplementing grain will further increase gain and

market grade of some classes of animals grazing alfalfa, indicating that despite alfalfa's high digestibility, energy is still a limiting nutritional factor.)

In many parts of the world alfalfa is commonly used to provide nutrition for various other animals including goats, oxen, and water buffalo. Alfalfa hay is widely fed to horses, mules, and donkeys, of course, and can also be used to provide pasture for them. The crop is fed to camels in the Middle East, to llamas in South America, and to ostriches in South Africa. Alfalfa hay is also a preferred feed for zoo animals in the United States and elsewhere.

At one time alfalfa was commonly used to provide pasture for hogs, especially for breeding animals (older hogs are able to utilize alfalfa much better than are growing pigs). Though the crop is rarely used for poultry in the United States, in many parts of the world it is used with great success in pasturing poultry.

Physical Characteristics

When growing in the field, alfalfa may contain as much as 80% moisture. This means that if a cutting taken for hay and baled at 16 to 18% moisture exceeds a yield of 1 ton or more/acre, over 1,000 gallons of water/acre must be lost from the hay prior to baling.

Most flowers of alfalfa are purple. However, occasionally a plant may be found which has an unusual flower color. This is due to the fact that germplasm from which alfalfa developed included *Medicago falcata*, which has yellow flowers. Consequently, an occasional alfalfa plant may have yellow, cream, white, or variegated flowers.

Though farmers don't spend much time looking at alfalfa roots, most know that alfalfa has a taproot-type root system with branching of lateral roots near the soil surface and root hairs originating from the larger roots. It is known that drier soil leads to deeper and more branched rooting patterns in alfalfa than do more moist conditions. In some soils the plant's taproot can allow it to obtain moisture from depths of more than 20 feet.

We think of alfalfa as being a trifoliate-leaved species, but there are also multifoliate-leaved types. In fact, leaves with as many as 11 leaflets have been reported. At least one cultivar with almost all leaves exhibiting the multifoliate-leaved character has been released.

Leaf area index (LAI) is the ratio of plant leaf surface to land surface. This is an interesting and useful measurement because it provides insight regarding the potential for sunlight interception, carbon dioxide exchange, and growth. The LAI of alfalfa is typically around 4 to 6 (4 to 6 times as much leaf surface as there is

land surface in a given area) during the first harvest or two of the year and then declines as harvest yields decline later in the growing season. However, in controlled environments, LAI's for alfalfa as high as 12 to 15 have been recorded.

The distribution of alfalfa leaves within the canopy varies depending on the growth stage of the crop. At about 2 weeks before harvest the largest concentration of leaf area will be in the upper portion of the canopy. However, at early to mid-flower the largest concentration of leaves will be in the middle of the canopy because new leaf formation in the upper portion of the canopy is suppressed during the reproductive phase.

Alfalfa leaves track the sun by changes in leaflet angle and by changes in compass direction, an ability which favors increased photosynthesis. Leaflets deep within the canopy are more effective at doing this than are upper leaves. However, when plants are under drought stress, this process doesn't work like it normally does. Thus, the plant's need to conserve moisture can override its need to increase sunlight interception.

Nitrogen Fixation

The biological nitrogen fixation which occurs as a result of the symbiotic relationship between legumes and Rhizobium bacteria is a unique and extremely important process, and alfalfa is one of the very best nitrogen-fixing legumes. Estimates of the annual nitrogen fixation have been as high as 413 pounds/acre, and around 200 pounds/acre is considered average from a good alfalfa stand. One scientist documented the fixation of near 160 pounds of N/acre during the establishment year.

Pests

Pests cause much economic loss in alfalfa production. It has been estimated that about one-fourth of the U.S. alfalfa hay crop and one-tenth of the seed crop are lost annually to diseases alone. In addition, over 100 insects are known to damage alfalfa. One researcher listed 21 diseases, 10 insects, and 3 nematodes as being major production hazards. Fortunately, not all of these are present in any one area or are present all of the time.

Plant breeding has significantly increased the resistance of alfalfa to plant diseases, and variety selection is therefore our primary weapon against disease losses. At present there are over 200 varieties of alfalfa commercially available in the United States, and numerous new varieties come available each year. Most commercially-available varieties have been developed by private companies.

The single most damaging pest of alfalfa in the U.S. is the alfalfa weevil. Most damage from this insect results from the feeding of alfalfa weevil larvae on

interveinal tissue. However, in some locations it is possible (though rare) to have late season damage from this insect as well.

There are also more than a dozen species of blister beetles in the U.S., at least six of which can cause poisoning of livestock, especially horses. Some blister beetle species are more toxic than others. The larvae of some blister beetles are beneficial because they feed on the eggs of grasshoppers and crickets. Interestingly, because of this the populations of blister beetles tend to rise and fall with the rise and fall of grasshopper and cricket populations.

At least four species of grasshoppers are important pests of alfalfa. Weed control in alfalfa or in areas near alfalfa fields may help reduce grasshopper damage, because grasshoppers feed on many common weeds. Though various herbicides can be used to control weeds in alfalfa, the single best defense against weeds is a good stand of alfalfa, due to its competitive ability which arises from its tremendous regrowth potential.

Forage Quality

Even when alfalfa is in the prebud stage, leaves are more digestible and contain more nutrients than stems. However, extremely young stem tips may be equal in digestibility to leaves. As plants move from the early vegetative to the late bloom stages, the nutritive value of stems drops rapidly, but the forage quality of leaves deteriorates much more slowly. Leaf digestibility varies only slightly with maturity and position within the plant canopy.

The rate of change in digestibility in alfalfa is strongly affected by temperature. Therefore, the rate of decline in digestibility over time is faster in summer when the temperature is high than in spring or autumn when temperature is lower.

A decline in stand density has little or no direct effect on forage quality of alfalfa; the digestibility of alfalfa leaves and the digestibility of alfalfa forage overall is about the same regardless of stand density. Nonetheless, the forage quality of vegetative growth harvested from alfalfa fields may decline as alfalfa stands decline due to increased presence of weeds or companion grasses in the stand.

Drought stress reduces the vigor of alfalfa, often resulting in stunted plants and reduced yields, but drought-stressed alfalfa tends to be leafier and to have finer stems, reduced fiber concentration, and increased overall digestibility. Therefore, though drought reduces alfalfa yield, moderate drought stress may actually increase forage quality.

Yield

One of the reasons alfalfa is such an important and valuable crop is its high yield potential. A seasonal yield of over 24 tons/acre has been produced under irrigation in Arizona. In addition, seasonal yields of over 10 tons/acre have been obtained from non-irrigated alfalfa in several states, including Michigan and Kentucky.

Yields of alfalfa typically decline in successive harvests within a growing season. This is true in areas in which alfalfa is cut as many as 7 to 10 times/year as well as in areas in which it is only cut 3 times/year. This is believed to be primarily related to temperature and photoperiod influences.

Stand density has less effect on yield of alfalfa than it might seem it would have. Significant reductions in plant populations may have relatively little impact on yield (to a point at least), because as plant populations decline, alfalfa tends to produce more stems/plant, thus compensating at least partially for the reduced numbers of plants.

Food Reserves

Carbohydrates (food reserves) are stored in the roots and crowns of alfalfa plants. The initial growth of alfalfa in spring or after each harvest must come from this stored food supply. Once there are enough leaves present, the amount of carbohydrates being produced by photosynthesis exceeds the needs of the plant for growth and respiration. The maximum amount of carbohydrates in the roots and crown occurs between 10% flower and full bloom. Thus, carbohydrate accumulation or depletion fluctuates sharply with frequency of harvest.

At high temperatures plant respiration may exceed the rate of photosynthesis. If this continues long enough, food reserves may be used up, especially if temperatures are high and the alfalfa is being harvested frequently. This phenomenon is sometimes called "heat induced plant starvation."

Seed And Seed Production

Alfalfa seed are typically kidney shaped, but some seeds have unusual shapes due to forces that are exerted on them in the pod during seed formation. When mature, seeds are approximately 1 to 2 mm long, 1 to 2 mm wide, and 1 mm thick (about 0.04-0.08 inches long, 0.04-0.08 inches wide, and 0.04 inches thick). One researcher who analyzed 418 seed lots consisting of 39 cultivars found an average of 465 seeds/gram (13,286 seeds/ounce). Most alfalfa seed is either yellow or olive green to brown, but white- and black-seeded genotypes have been reported.

"Hard seed" percentage in alfalfa varies greatly depending on several factors including variety, environmental conditions, and harvesting technique. Though alfalfa seeds contain a cuticle made up of fatty acids and waxes, the moisture barrier in hard seed of alfalfa is not the seed coat (as is the case with many plants); rather, it is a thickened layer of palisade cells which lies beneath the seed coat. It is relatively easy to reduce the hard seed percentage of alfalfa by mechanical means.

Under proper storage, alfalfa seed can remain viable for a long period of time. One investigator found 7% viability in a seed lot which had been stored for 70 years. In another experiment, 3 lots which had been kept at subfreezing temperatures for 20 years had declines of germination that were only between 3 and 13%.

Alfalfa seed yields sometimes exceed 1,800 pounds/acre and the annual production of alfalfa seed in the U.S. is usually more than 110 million pounds. Most of this production is in the states of California, Oregon, Idaho, Washington, and Nevada.

Use of bees for alfalfa seed production is a science unto itself. Honey bees, alkali bees, and leafcutter bees are used in various areas to provide pollination. When honey bees are used, more than two colonies/acre can be beneficial as the most effective pollination activity occurs within a 300 foot radius of a colony.

Unless fields are small, it is more effective to place honey bee colonies within fields than around the borders. Placing barrels of water at various points within a field help keep the bees working in the alfalfa. Beekeepers must monitor the hives closely during the pollination period and periodically add more honey supers with empty frames within them to keep bee activity high.

Alkali bees and leafcutter bees are solitary insects used to pollinate alfalfa in the Northwest. Alkali bees live within the soil. Some alkali bee beds occur naturally, but special beds can be prepared for them as well. Leafcutter bees live in holes in wood or other materials, and suitable habitat for them can be artificially constructed and then be transported from location to location as needed.

Conclusion

Alfalfa has been an important forage crop for centuries and, not surprisingly, has therefore been the focus of more research than any other forage species. Countless experiments have generated reams of data and have revealed many facts about this valuable species. Even some of the less widely-known (or less frequently discussed) facts about alfalfa are interesting and help provide insight regarding this remarkable plant.

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